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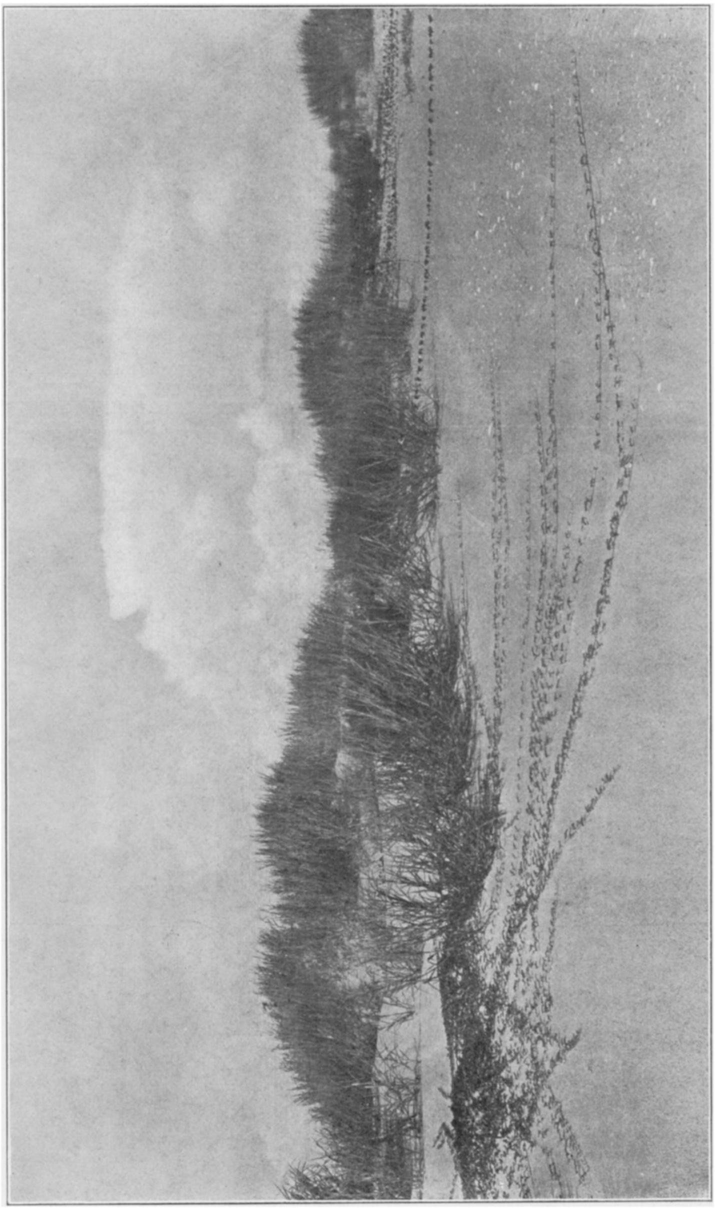
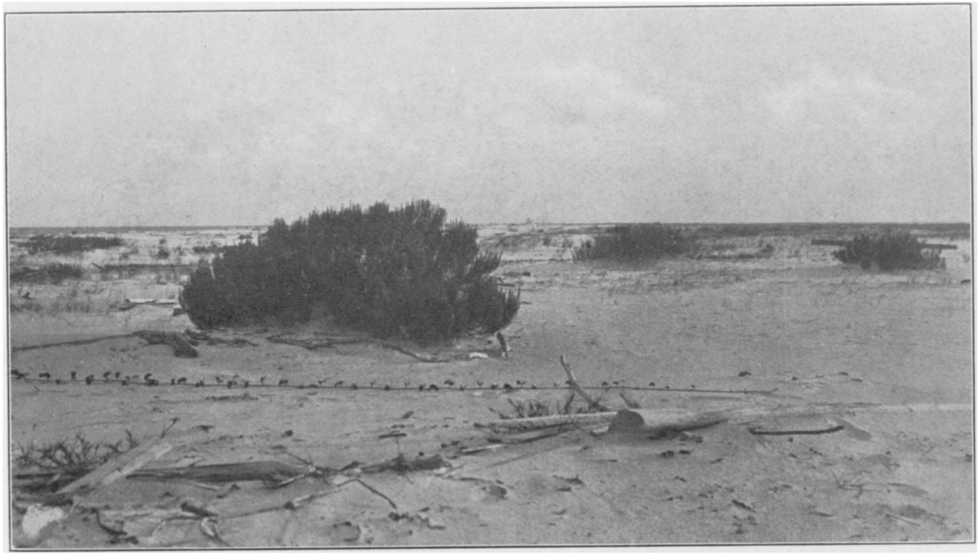
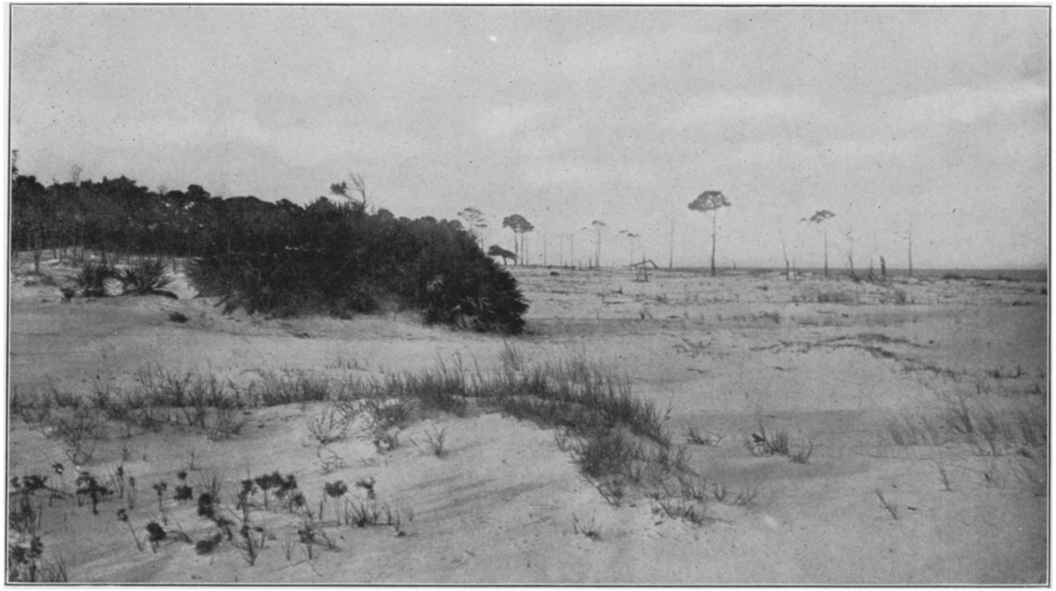


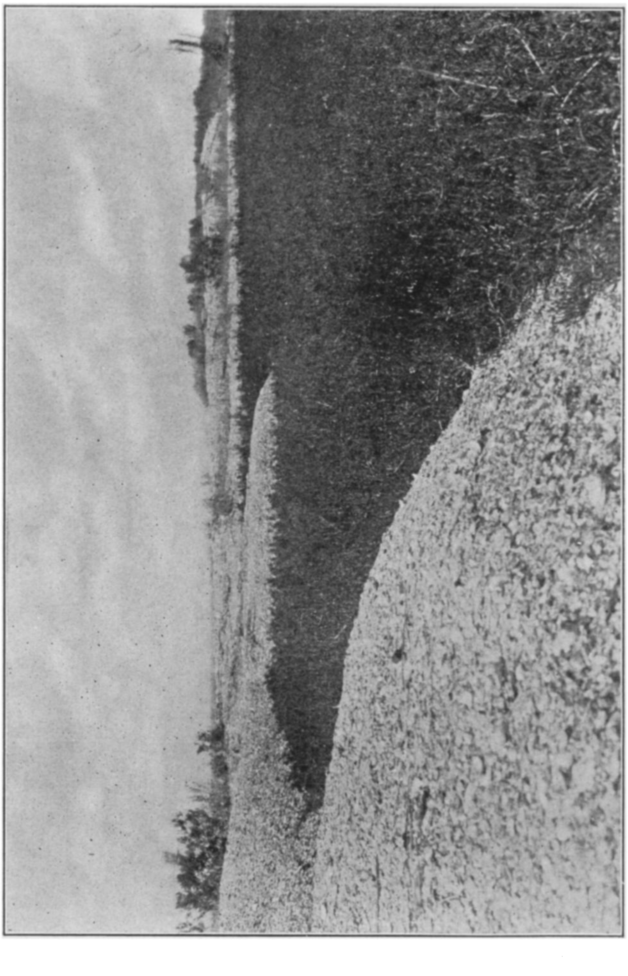
Panicum amarum dunes, with *Ipomoea acetosaefolia* on the extreme left foreground and *I. Pes-caprae* on the extreme right.



Iva imbricata dunes on the sand spit plain; a stem of *Ipomoea Pes-caprae* in the foreground.



Sand spit plain. *Serenoa serrulata* dunes. In the middle foreground a *Panicum repens* dune. Left foreground *Cyperus cylindricus*. *Pinus Taeda* in the background; pine graveyard on the right.



Shell dune showing lee margin encroaching on a pure *Batis* association. On the dune *Iva frutescens.*

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The insular Flora of Mississippi and Louisiana

BY FRANCIS E. LLOYD AND S. M. TRACY

(WITH PLATES 8-11)

During the summer of 1900 the writers made a brief ecological survey of the more westerly islands of the Mississippi Sound Islands and Delta. The islands visited were Ship Island, Ile à Pitre, Sundown Island, Sam Holmes Island, Mitchell Key, Brush Island, Battledore Island, the Hog Islands, Breton Island, the Bird Islands, and the Mud Lumps. The Delta proper was visited at two points in the South Pass, namely, at Port Eads and at a point a few miles north of that place. The field work was done during the three weeks between the 10th of August and the 1st of September, at a time when the summer vegetation is at its height.

In order that the present avowedly brief and imperfect study may be made of definite interest, a comparison has been instituted between the region here considered and the island of Ocracoke, the only point on the coast of North America which has so far received careful ecological study, and which, according to Kearney's results, lies "well within the lower austral life zone in North America." (5) The region here considered occurs in the longitudinal center of the Gulf Strip of the Austro-riparian. Between the two regions the difference of longitude is about thirteen degrees, of latitude five degrees. What the significance of this difference is will be seen the better by a comparison of the climatic conditions.

[Issued 2 March.]

CLIMATE

The data here used have been derived from the Annual Report of the Monthly Weather Review for the past eight years, the New Orleans data being used.

TEMPERATURE

The mean annual temperature of the Delta is near 21.1° C., while that of Ocracoke is 16.3° C., a mean difference of nearly 4.9° C. (9.0° F.). The maximum temperature is 36.1° C. (97.0° F.), and the minimum — 16.1° C. (7.0° F.), the lowest and highest points registered in eight years. In this regard the two places differ but little. As the accompanying curves (Fig. 1) will show, however, the general temperature is higher, and the growing season longer, at the more southern point, as shown by the more rapid rise of the curve after the middle of February, and the steady maintenance of an effective growing temperature in the earlier and later months of the growing season. And in this lies the chief climatic difference of physiological moment between the two places here under consideration.

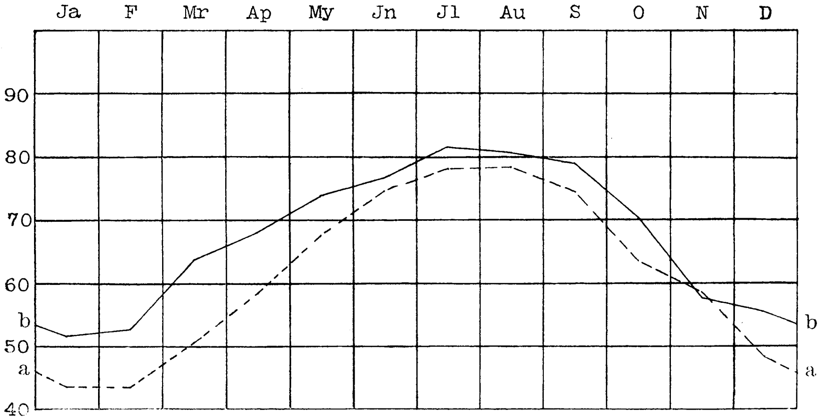

FIG. 1. Curves showing the mean monthly temperatures of Hatteras (*a–a*) and the Mississippi Delta (*b–b*).

One might readily suspect that the meteorological observations made at New Orleans would show some variation from the conditions found on the small islands of the Delta and adjacent parts. A comparison of data taken at New Orleans and the rather fragmentary official collection of data from Port Eads, at the southern end of the South Pass, indicates that the temperature variations between these two places are slight. As the latter place may thus be taken as a criterion of the conditions on the islands, we may regard the New Orleans data as fairly close to the truth.

It may, however, be mentioned in passing that our own observations during two weeks of August spent among the islands proper showed a range of temperature between 26.6° C. and 30° C. and a maximum daily range of only 3.4° C., the readings being taken in the shade. It may also be mentioned in this connection that the water temperatures showed about the same amount of variation (27.1°–30.5° C.), and a mean temperature higher than that of the air by 0.5°–1° C. This continual high temperature of the waters is due undoubtedly to their extreme shallowness over large areas.

PRECIPITATION

The precipitation of this region is heavy and is composed almost entirely of rain. The records show a mean annual rainfall of about 154.94 cm. (61 inches), less by 16.51 cm. (6½ inches) than than that of Ocracoke. This difference is of little or no physiological importance because the vegetation is near the water table, and because of the continuous high relative humidity. Only one other region on the Atlantic Coast has as great a rainfall as the Hatteras region and the one here considered, namely a part of southern Florida. The Delta region, however, is somewhat more subject to sudden storms than Hatteras as is indicated by the relative frequency of thunder storms in the ratio of 4 to 3. Droughts do not occur, as the rainfall is pretty evenly distributed throughout the year, and there appears to be little or no tendency to concentrate it at any season of the year. Thus a given month which shows six or seven inches in one year may show as low an amount as one or two in another year.

ATMOSPHERIC HUMIDITY

The percentage of possible saturation of the air may vary between 66 and 84, the annual average being 77, less by 4.4 per cent. than that of Ocracoke. The degree of humidity is however, high, and varies but little from month to month.

SUNSHINE

The data available are those based upon six years' observation. These show that the average number of cloudless days per annum in this region is 154 against 141 at Hatteras, while the average number of totally cloudy days for the two places is very nearly the same. The average total number of partly cloudy days is accordingly less for the Delta region (117 to 130) giving that region an amount of sunshine greater by about 21 days. This and the lower relative humidity of the atmosphere, indicate an amount of energy available in the form of light considerably greater than at the more northern station, namely Ocracoke.

WIND

The average velocity of the wind is very near to 13.2 kilometers (8.2 miles) (Hatteras, 21.4 kilometers (13.3 miles)) and the total wind movement per annum, 118740.3 kilometers (73,619 miles) as compared with a wind movement of 191,935.5 kilometers (119,000 miles) at Hatteras.* The total wind force is therefore small. The prevailing direction of the wind is southeast. The total wind movements, however, from the south points of the compass exceed those from the north points by only a little, and are to each other in the ratio of 10 to 8. This fairly equal distribution of winds about the points of the compass accounts for the absence, for the most part, of those asymmetrical growth forms which are referred to the mechanical action of the wind. The direction of the wind in summer months is almost constantly southeast and the small amount of distorted growth is due to this fact as the direction which that growth takes indicates.

Summing up the above data the climate of the delta region may briefly be described as having: (1) A very long growing season, as shown by the sudden rise of the curve in the accompanying figure (Fig. 1), after the middle of January; (2) A large amount of precipitation well distributed throughout the year; (3) A high relative humidity with little annual variation; (4) A high degree of insolation, the effect of which is somewhat lessened by the high relative humidity, and (5) A relatively small wind force well distributed as to direction. These factors are on the whole quite favorable to plant growth.

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* Based on six years' observations.

SOIL TEMPERATURES

A number of observations were made by means of a properly calibrated soil thermometer. Temperatures on the surface and at a depth of 10 cm. were taken on clear days and indicate the amount of heat to which the vegetation is exposed in ordinary summer weather. The results are as follows:

Surface of wet sand, 36° C.
Wet sand, 10 cm. deep, 32° C.
Surface of dry sand dune, 35.5° C.
Dry sand at 10 cm. 32° C.
(Air temp. at same time, 30° C.)

At a point near Port Eads, where some coal dust had been mixed with the alluvium, and where some euphorbias and a few other strictly radiate plants were growing, the surface temperature was 50° C. The surface temperature of sun-baked alluvium at 10–30 on the same day was 44° C. Here crotons, sidas and some other plants were found plentifully.

The temperature of the surface of a salt muck marsh was 38° C., and at a depth of 10 cm. 31° C.

These observations, though scanty, indicate a high soil temperature which probably often exceeds that observed.

GENERAL PHYSIOGRAPHIC FEATURES

The islands visited are of three distinct types: (1) The muck marsh islands; (2) The sand islands; (3) The mud lumps. They owe their origin to deposits of drift and alluvium from the Mississippi River. Of the first group Ile à Pitre, Sundown, and Sam Holmes Islands are types; Ship, Cat, and Breton Islands belong to the second type, while the third, the "mud lumps," consists of a large number of nameless islands just outside the several passes which form the main outlets of the river.

1. *The Muck Marsh Islands.*—These are near the outlet of Lake Borgne, Cubits Gap, Thompson's Pass, and the numerous bayous above the mouth of the river and are probably of the most recent formation. They are low, level and mostly small, many of

them being only a few acres in extent. They are composed of a very fine black alluvium which is so soft that a pole or an oar can be pushed into it one or two metres with very little exertion, and the soil seems to be held in place principally by interlacing roots of maritime plants. The water between these islands is usually shallow, seldom being over 1.6 meters in depth, and always more or less cloudy from the admixture of muddy water from the river.

Oysters are very abundant in the brackish waters, and the islands situated in the oyster region and exposed to violent wave-action often have a beach from two to several meters in width, formed of shells which are more or less broken. In all cases this beach is found only on the seaward side of the islands, and always resting on a foundation of black muck. In nearly all cases the muck foundation is bare and plantless from 0.5 to 2 meters from the water line; then comes a ridge of shells from two meters to sometimes as much as twenty meters in width and from 3 dm. to a meter high, the crest being near the river side, and the inner slope very abrupt. These shell beaches are found only on the shores of the muck marsh islands.

2. *The Sand Islands.*—These islands are from five to fifteen miles from the mainland, outside of Mississippi Sound, and probably owe their origin to the same causes which formed the muck marsh islands, though they are now covered for the greater part with sand. A close examination will usually show that a part of each one has the black, mucky foundation of the marsh islands, and if not found elsewhere some remains of this original soil can usually be found on the southeast side of the island where it is most exposed to erosion by winds and waves. All of these sand islands are moving to the northwest, in the direction of the prevailing winds. The southeastern shore is usually abrupt, with deep water within a few meters of the beach, while in nearly all cases the western end of the island is a long and almost barren sand spit, and often extending a mile or more farther in the form of a sand bar which is uncovered at low tide. The sand covering of these islands is only a few centimeters deep in some places and so low as to be constantly wet, forming sand marshes, while in other places the surface is raised from one to three meters, or even into dunes twenty-five meters in height, as on Cat Island. Of course

the amount of moisture in the sand varies with its elevation above tide and the greatest variety in flora is found on the largest islands having the greatest variety of soil and elevation.

3. *The Mud Lumps.*—The mud lumps vary in size from a few square rods to perhaps fifty acres. The general surface is somewhat undulating, and from one to three meters above tide. The soil is very compact, black or yellowish, with almost the texture of joint clay. None of these islands showed any of the usual signs of growth on any side, while all appear to be wearing slowly from wave action.

The contiguous waters are very shallow and the amount of salt held in suspension is considerable, decreasing as one passes seaward. The algal vegetation is small, even in the most favorable locality visited, Breton Island, and is to be found chiefly in the lee of the island. The collection has not yet been studied, and remains to be reported upon later.

Such extensive shallow waters, especially in the lee of an island, favor the extensive growth of *Ruppia*, with, however, scarcely any other plant save the few algae.

THE PLANT COVERING

Any attempt to present an analysis of the floral covering of the region just briefly described must of necessity be more or less unsatisfactory, for an analysis attempts to present the conditions as they are, while in point of effect we are dealing with a series of changes in those conditions. It must be admitted also that but few plants are habitually confined to one association, or even formation, and to delimit these is often no easy task, involving much more time in the field than the writers have had at their disposal. The following account may be claimed to be a fairly true picture of the conditions described, but would probably need revision as to details on subsequent investigation.

SAND STRAND VEGETATION

Beach formation.

Lower beach : no vegetation.
Middle beach.
Upper beach : *Panicum amarum* association.

Sand plain formation.
  Sand spit plain: open, treeless, subject to inundation.
    Basins: *Hydrocotyle* association.
    Dunes.
      Grass dunes: *Panicum repens.*
      Pedestal dunes: *Iva, Serenoa.*
    Flats: *Cyperus.*
  Grass-covered sand plain, not subject to inundation.
  Established sand plain, tree-covered, not subject to inundation.
    Pinus-Sabal association.
    Quercus geminata association.
Sand dune formation.
  Established dunes of low stature; *Myrica-Ilex* association.
  High, wandering dunes.

SHELL STRAND VEGETATION

Shell-dune formation.
  Shell beach.
    Lower.
    Middle: *Euphorbia-Strophostyles* association.
    Upper: *Iva frutescens-Lycium* association.

SALT MARSH VEGETATION

Muck marsh formation.
  Batis-Salicornia association.
  Grass associations.
    Pure.
    Mixed.
Shell-muck marsh formation.
Sand marsh formation.
  Sand-muck marsh: *Juncus* association.
  Sand (pure) marsh.

SAND STRAND VEGETATION

Beach Formation (Plate 8)

As one would expect, in a region where the water is very shallow the beaches are wide and have a very gentle slope. Such beaches are also subject to the action of the waves, and the plants which grow in this habitat are therefore exposed to the danger of wave action, as well as that of the wind. Their roots are of course in strictly saline conditions. There is little or no movement of the substratum due to the effect of the wind, at least in ordinary times, inasmuch as the sand is compacted by the water of capillarity.

Here as elsewhere according to the studies of Macmillan, Cowles, Kearney, and others in this country, the beach formation is readily divided into three main zones, namely the lower, middle and upper beaches. As the tides are here quite slight the lower beach is narrow as compared to that in most maritime regions. Vegetation is either entirely absent, or there may be at most a meagre and inconstant algal association. The middle beach (midstrand) is relatively broad and the physiological conditions are extremely unfavorable on account of the above-mentioned saline soil conditions and on account also of the intense light and heat aggravated by the strongly reflecting surface of the sand. The plant covering is very sparse consisting of succulent annuals of the cespitose and radiant habit of growth. Two zones are distinguishable, an outer, seaward zone occupied chiefly by cespitose forms such as *Dondia linearis*, *Cakile fusiformis* and *Salsola Kali*, with the grass *Cenchrus megacephalus* which grows nowhere else. Towards the upper limit of this zone the radiant form *Sesuvium portulacastrum* is to be found, but no such massing of this plant such as was seen by Boergesen and Paulsen in the Danish Antilles has been observed. *Eragrostis secundaeflora*, is also a beach plant and responds to the high humidity of the region after the manner of some other grasses (*Poa alpina*, *e. g.*) to similar conditions, by becoming strongly proliferous. The inner, landward zone is characterized by a growth of *Ipomoea Pes-caprae*,* *I. acetosaefolia*, *Strophostyles helvola* and sometimes *Canavalia obtusaefolia*. These, with the exception of *Strophostyles*, are preëminently tropical strand plants whose ecological features have been described by Warming, Schimper, and others. All of these three forms reduced the layer of over-insolation by bringing the leaf's surface into a vertical position, *Ipomoea Pes-caprae* by folding the leaf at the midrib, *I. acetosaefolia* by folding the lobes of the leaf on their chief veins, and *Canavalia* by bringing the leaflets separately into the vertical by means of the motile organs at their bases.

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* Stems of immature plants 30 meters long, were found. Dr. H. J. Webber tells me (F. E. L.) that he has measured stems nearly four times this length on the Florida coast.

Strophostyles helvola, on the other hand, is a plant of wide northern distribution. It is of much smaller stature, but has very much the same ecological development as *Canavalia.* No one of these plants may be described as dominant in this region, except in one restricted locality on Breton Island where the two species of *Ipomoea* form a network covering the soil much as described by Schimper. (See Plate 8.) They do not, however, even here serve to attract other plants and the association is poor in species. Associated with the just mentioned prostrate forms are a few sedges and some grasses, notably *Spartina* and *Panicum amarum*, the latter in isolated clumps between which usually germinate the seeds of the prostrate vines already named and from which the plants extend their runners in various directions, but chiefly toward the lower beach.

The upper beach extends from the upper limit of high water and ordinary wave action, and shades off on the inner side into a sand plain formation to be considered beyond. The name upper beach is less appropriate than back strand, because the zone, properly speaking, is not a beach, as Cowles has pointed out. The term strand has, however, been given a much wider application, so we choose for our present purposes the word beach. The upper beach, then, is composed of very low dunes, caused by accumulations of sand about the grass, *Panicum amarum*, which here attains full development. Associated with *Panicum amarum*, a maritime plant found as far north as Long Island, is another large grass of more southern distribution, *Uniola paniculata*, which grows in scattered clumps, adding to the otherwise monotonous grass of the beach dune vegetation a very striking element of beauty in its gracefully curved large inflorescences. *Uniola paniculata* is, however, of much less importance as a sand-binding grass than it appears to be on the east coast of Florida or on Ocracoke, according to Webber (11) and Kearney (6), respectively. The quantitative relation, stated by Webber, namely, that in Florida it forms 75 per cent. of the vegetation is about reversed, *Panicum amarum* taking the lead to that extent.

Yucca gloriosa also appears occasionally as a striking feature of the beach dunes, as was observed on Breton Island.

Panicum amarum appears to correspond in its habitat and behavior to *Spinifex squarrosus* of New Zealand, as described by Schimper.*

The upper beach association may at times consist wholly of three plants, *Panicum amarum*, *Ipomoea Pes-caprae* and *I. acetosaefolia* (Plate 8). This occurs if the width of the island is not great enough to permit the growth of vegetation in the lee of the dunes. If, however, as occurs in the older, wider portions of an island, an accumulation of sand of some depth has taken place, or if the island has been extended into a sand spit of considerable area, other conditions are set up which we describe under the following head.

The Sand Plain Formation (Plates 9 and 10)

Floristically considered there are three leading types of the sand plain. These may be distinguished also by age, in the order of which they may very properly be described.

The youngest is the sand spit plain. This is usually a low-lying extent of sand, hot, brilliantly lighted and wind swept. It is also subject to inundation by the sea during heavy weather (Hilgard). Being continuous with the older part of the island, their beaches are continuous. The lower beach of the sand spit is less steep and strand pools are of frequent occurrence. The middle beach is in like manner less abrupt, and is coördinately much broader. The dunes of the upper beach may usually be followed for some distance from the older part of the island, but they sooner or later fail. The whole area of the plain is then open to the sea without the protection offered by the dunes, and produces a scattered vegetation of the beach annuals together with perennials of similar ecological character.

The occurrence of driftwood or of plants on the plain causes irregularities in the surface. These are of the form : (1) Of shallow depressions or basins of small extent usually below the general level and very generally wet ; (2) Of low dunes ; and (3) Of more or less level stretches of sand.

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* Pflanzengeographie auf physiologische Grundlage.

In the basins one finds a scanty vegetation, a species of *Hydrocotyle* being the most constant element. The plant has prostrate buried stems and only the leaves and inflorescences appear above the surface. The petioles are vertically placed and the peltate leaf-blades are also strictly vertical, although no orientation was observed. *Mollugo verticillata* is to be found here also.

In the second place the surface may be raised locally into dunes of usually inconsiderable size. The dune formers are the grasses on the one hand (*Panicum repens* and *P. halophilum*) and chiefly two perennials, *Iva imbricata* and *Serenoa serrulata*, which here grow in symmetrical cespitose clumps and gradually collect about their bases a dune upon which they raise themselves above the general level, and so become raised upon a pedestal of sand. For this reason the name pedestal dune appears to be appropriate to this dune form. The absence of strong continuous winds may account for the ability of these plants to act in this manner.

Extending between the elevations and depressions are more or less level reaches where a number of plants grow whose form does not favor the accumulation of sand about them, plants namely which do not tend to produce a network of stems, such for example as some sedges (*Scirpus Americanus*, *Cyperus cylindricus*). There occur also a few small plants of the radiant type and some grasses (*Diodia teres*, *Sesuvium*, *Syntherisma fimbriatum*, *S. filiformis*, *Cenchrus incertus*, *C. tribuloides*, *Euphorbia cordifolia*). *Physalis angustifolia* is also frequently met with.

The second type of sand plain referred to above may be designated as the open, grass plain, characterized as it is by a plant covering of a large number of herbaceous species of low stature among which the grasses greatly predominate. Some of the grasses, however, are of large size, *Chaetochloa magna* and *Uniola paniculata* for example. The other prominent feature is effected by a heavy growth of slender vines (*Vigna glabra*, *Clitoria mariana*), sometimes so dense as to cover the other vegetation out of sight, and covering considerable area. On the whole the conditions in this type of sand plain are decidedly mesophytic as compared with the beaches and other formations here described, because of the dense covering of plants and because also of the much less salt content of the soil. Two species of *Commelina*, *Chamaecrista littoralis*, *Gerardia purpurea*, *Croton maritimum* and a goodly number of low mesophytes complete the association.

The third type of sand plain is the forest-covered area to be found only on the larger islands of the Mississippi Sound, where a large area has been for a long period of time removed from the immediate influence of the sea. Regarding Cat Island as a type, the plain may be described as established, inasmuch as the surface is subject to erosive agencies only to a very slight degree. There are no water courses, unless one would attach that name to sloughs in which the water is practically at a standstill. The wind can have but little effect upon the topography, as the soil is moist and moreover is protected by the tree covering, while the force of the wind is broken by the large dunes lying to the windward. The surface is level save for a few low sand mounds which are not improbably to be regarded as fossil dunes, whose topography is at present beyond the influence of erosive or moving agents. Elsewhere the surface is lowered a little and the soil becomes much wetter. Broadly speaking the whole area is covered by a forest of pines of two species, *Pinus australis* and *P. Taeda*, with *Sabal glabra* and *Serenoa serrulata* as prominent elements in the undergrowth. In the wetter places under the shade of the palmetto last named, a hepatic (*Pellia* sp.) was found in abundance in August, and there is reason to believe that in the winter season a number of species would be met with. In general, one may say that the pine-covered plain is ecologically a part of the coastal plain of the mainland, and that the flora differs from that of the pine barrens of the coastal plain in scarcely anything except in the number of species. So, too, with the mounds or fossil dunes above referred to upon which one finds invariably a growth of live oaks, generally *Quercus geminata*, or less frequently *Q. Virginiana*, under the shade of which, and in a soil of much greater organic content, grow a group of plants commonly found on the mainland in like situations. The tree trunks are clothed with incrusting lichens, while from the branches grow *Ramalina* and some foliaceous species. On the lower parts of the trunks, and on the ground, mosses (*Leucobryum* especially) and liverworts grow. The lichen *Cladonia rangiferina* in rich fruiting condition was also found growing in clumps on the ground. Beyond the shade of the trees, on the slope of the mound *Opuntia Pes-corvi* and *Baldwinia multiflora* are to be found together with a little convolvulus, *Breweria*, forming, however, a scanty plant covering only. Attention should be drawn to the fact that the epiphytic plants (*Polypodium polypodioides* and *Tillandsia usneoides*) which are so common on the live-oaks of the nearby mainland, are here entirely absent.

Sand Dune Formation

In addition to the dunes already described in connection with the sand beach and sand plain formations there are two other dune types which still remain to be mentioned. These are the established dunes of low stature and the high wandering dunes.

The former occur notably on Breton Island, and are usually less than one meter in height. They are clothed with a thicket of *Ilex vomitoria* and *Myrica Gale*, and with these is an undergrowth of herbaceous plants such as have been referred to in the description of the open grassy sand plain, of which in point of fact, this *Ilex-Myrica* dune formation is a part which has changed its aspect as a consequence of the growth of those evergreens. The cause of this change is obscure, but it seems probable that the shrubs have been better able to establish themselves on the lee of the grass plain. The formation corresponds very closely to the thicket formation of Ocracoke described by Kearney, but lacks the particular species mentioned by him. Owing to the rather heavy protective covering of shrubby vegetation these low dunes are not affected by the wind to an appreciable extent and may therefore be regarded as in a relatively static condition, or otherwise expressed, as established.

Only one of the islands visited affords conditions favorable for the formation of the high, wandering dunes, namely Cat Island, where they are to be found on the windward side. They are arranged in a linear system which lies parallel with the shore line, and range in height from ten to twenty meters. The most northerly dune of the system is the highest, and constitutes on this account a prominent landmark. It is quite naked save on the lee slope where a few annuals, *e. g.*, *Jatropa stimulosa*, *Cenchrus* sp. and some others, gain a temporary foothold in the shade of the trees which are doomed to partial or complete burial. The only relation which this dune in particular holds to the vegetation is that of a destructive agent, for the pines especially are not able to withstand the burial in sand. The live-oaks are, however, more resistant, and many examples of trees may be seen with only the ends of their branches protruding above the sand, and having the appearance of vigorous shrubbery. The branches of these oaks are covered with a growth of crustaceous lichens and a species of *Ramalina*, while an occasional annual grows in their shade upon the dune surface.

The other dunes of the series have on their windward slopes a vegetation of annuals and perennials composed chiefly of *Iva imbricata* and *Serenoa serrulata*, with occasional clumps of *Uniola paniculata*, *Siphonychia corymbosa* and species of *Euphorbia*, plants which are by no means confined to this habitat, as the reader has already seen. The lee slope, which in all cases observed is very steep, recalling the appearance of the dunes of Figs. 15 and 16 of Cowles' paper supports no plants excepting a meagre, but never too meagre, growth of *Cenchrus*. These dunes are in rapid motion, and have left behind them a "graveyard" of dead pines. Their motion is evidenced not only by the character of the lee slope but also by the distorted, protruding, but still living leaves of engulfed plants of *Serenoa*. Reference has been made to the low sand mounds encountered in the pine-clad plain as having originated as dunes, but which are now beyond the effect of the winds. Upon this explanation they may be called fossil dunes in a somewhat exact sense.

SHELL STRAND VEGETATION (PLATE 11)

In the general account of the physiographic features of the islands attention was drawn to the origin and presence of a dune of shells on the seaward margin of many of the low islands. There are two ways in which the dune may lie with reference to the margin of the alluvial plain upon which it is superposed. The figures here presented will show at a glance the difference. In the upper diagram (Fig. 2, *a*) the edge of the alluvium is bare, so that it is eroded by the waves, and *pari passu* the shell dune is advanced toward the lee edge of the island. Under some conditions the edge is eroded more rapidly than the shell dune is moved forward.

Or it may be also that the load of shells has not been lifted well upon the muck plain, so that in either case the seaward margin of the dune lies below the water level. In this way a shell beach is formed, such as is represented in the lower figure. A description of the latter condition will serve for the present purpose because, as will be shown, the flora of the two differs but little.

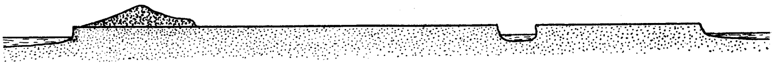

FIG. 2*a*. Diagram of a shell-marsh island at right angles to the shell dune.

The conditions of growth on a shell dune are as follows: Organic materials, as well as alluvial detritus are almost entirely absent as they are carried through by the percolating water, which at the same time reduces the salinity if the substratum. The degree of salinity may, however, be suddenly increased by the sea water in unusual weather. This absence of salinity is not true of the lower beach, which, however, is devoid of vegetation for other reasons. Water of capillarity is absent except rarely when the fragments are very small. A fair amount of moisture is, however, present because the shell fragments hold water better than might be suspected. These characters, taken together with the high temperature and intense insolation, produce a decidedly xerophytic condition. The percolating water contains probably an unusual amount of calcium carbonate, making the shell dune not unlike a coral beach.

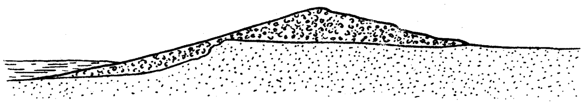

FIG. 2*b*.

In spite of such apparently unfavorable conditions, the small area of the shell dune produces a good number of plants.

Vegetation is not encountered in the lower beach or the lower zone of the middle beach. The plants of the upper zone of the middle beach are chiefly prostrate annuals, of which *Euphorbia polygonifolia* and *Strophostyles* are almost the only examples.

Chenopodium Berlandieri sometimes occurs. It is possible to point out the limit of the middle beach only in a loose way. For the present we regard the upper beach as occupying the ridge and the area behind it. Here the flora is very diversified. *Iva frutescens* is the first shrub to make its appearance, and this almost always heavily attacked by *Cuscuta Gronovii.* In lower places *Spartina polystachya* and *S. junciformis* and *Sporobolus Virginicus* are quite abundant. On the crests of the ridges *Dondia maritima* and *Atriplex cristata,* while here and further back *Lycium Carolinianum,Borrichia frutescens, Chrysoma pauciflosculosa,* and *Opuntia Opuntia* are the chief perennials. Among these *Ambrosia artemisaefolia, Leptilon Canadense, Lepidium Virginicum, Elymus Virginicus, Polygonum* and *Cakile fusiformis* form a weedy growth. Creeping over these plants are the vines *Seutera palustris, Vigna glabra* and *Ipomoea sagittata* and *I. commutata.*

SALT MARSH VEGETATION

Muck Marsh Formation (Plate 11)

The simplest salt marsh condition is to be found on those islands which are small and lie in a protected position so that the sea does not throw up the shell fragments which occur in the contiguous waters. An island of such character is a low-lying, alluvial flat with a surface which is nearly level. The flora is limited to a few species segregated usually in two easily recognizable associations. These are the grass association, either mixed or pure, and the *Batis-Salicornia* association. The former is to be found more often near the shore where the surface is a little higher than in the interior and is composed of *Spartina* (*S. patens* and *S. stricta*), which in many places are largely replaced by *Distichlis.* Other grasses are quite rare. The other association is composed of succulents of two genera, namely, *Batis maritima* of tropical and subtropical distribution, *Salicornia Bigelovii* and *S. ambigua.* The first-named is by far the most dominant plant, forming in some places a pure association covering acres of surface. A striking character of the plant is the strong development of cortical aërenchyma about the roots and the lower part of the stem. The anatomical characters of this and many others of the American tropical strand succulents have been described by Warming. The salicornias, which are plants of more northern distribution, are by no means so plentiful as *Batis*. They are, however, of the same ecological character, being stem succulents, while *Batis* is a leaf succulent. The only other plant occurring in the muck marshes is *Avicennia nitida*, with its well-known negatively geotropic roots (pneumathodes). This mangrove grows abundantly on some of the islands to the extent almost of the exclusion of other species (Breton Island), but in no case reaches a height greater than 60 cm. They produce, however, flowers and fruit. On some of the islands visited great numbers of dead plants were found which had doubtless been killed by the frost. The fact that all the dead ones were about of a size indicates that this plant is so killed and that it is here in its northern limit. The soil of the salt marsh is composed of a very finely-divided alluvium which packs very tightly, and this with the water which is saline results in a mass which effectually prevents the entrance of air. This accounts for the development of the pneumathodes of *Avicennia* and the abundant aërenchyma of *Batis*, paralleling the well-known structures of similar adaptive significance in many swamp plants.

The general appearance of the salt muck marsh vegetation is one of somber uniformity. The succulents are of the same height and color—a dark green, and the grass association is a bluish gray. The variety of color of the northern salt marsh plant covering is well-nigh absent.

From the above it will be seen that there are scarcely any plants common to the shell strand and muck marsh. Apparent exceptions (*e. g.*, *Spartina juncformis*) may usually be explained by the fact that the roots may penetrate into the mud through the shells. Marsh plants may thus be found in the shell strand, especially in the shell-muck marsh. The converse is scarcely ever true. The lee edge of the encroaching shell dune shows a sudden and complete change from the muck marsh, as is shown in Plate 4.

Shell Marsh Formation

In some instances the shell dune becomes broad and scattered on the inner limit and the shell fragments are mixed with the alluvium of the marsh so as to make a looser soil which is less homogeneous and better aërated. It happens also that the area may be better drained. In such conditions the plants are prostrate (*Lippia nodiflora*, *Lithophila vermiculata*) with the exception of *Salicornia*, one species of which has plagiotropous shoots. With these there was found on Bird Island a single plant of *Citrullus vulgaris*, a plant mentioned also by Kearney as occurring in a feral state on Ocracoke. *Limonium Nashii* grows usually in such a soil, and is to be found for the most part on the lee margin of the shell dune.

Sand Marsh Formation

On the larger islands the sand covering of the lee part of the island is sometimes so thin that the alluvial foundation is hidden by only a few centimeters. In limited areas, however, the depth of the sand may be greater. In these two ways the conditions for a sand marsh are set up in which the plants may be rooted in pure sand or partly in the underlying alluvium. The latter condition is especially favorable for the formation of a reed marsh in which species of *Juncus* are the chief factors. Marshes of this kind are sometimes of large area. When the sand covering is very thin, as is the case in parts of Breton Island, the sand marsh takes something of the character of the muck marsh, and *Batis* and *Salicornia* may occur. When the depth of sand is greater, which happens more frequently at a point more remote from the influence of the salt water an association of plants grows up in which *Xyris serotina*, *Utricularia subulata* and *Oldenlandia uniflora* are prominent members. The more shoreward stretches of wet sand are either naked or bear a sparse growth of small plants. Among the number are *Siphonychia corymbosa*, *Polypremum procumbens*, *Gratiola subulata* and *Diodia Virginiana*.

THE MUD LUMPS

The top soil of these islands is very thin, overlying a dense, sticky clay. The usual marsh and aquatic plants are almost wholly wanting, as are also pines and oaks. The more abundant grasses are *Spartina stricta* and *Capriola Dactylon*. The only large trees are melias which have doubtless been introduced. On one of these islands a dense growth of a trailing *Rubus* not observed elsewhere covered many acres. Tamariscinas and other Amaranthaceae are much more abundant here than on the sand islands. *Baccharis halimifolia* is abundant on all the mud lumps and is often the only woody plant.

THE DELTA

No attempt has been made in the preceding pages to include a treatment of the phytogeographical conditions of the land of the Delta, since it is a part of a region which justly requires a separate study. The general statements pertaining to the more recent part of that area are as follows.

The "passes" of the Mississippi River are broad channels of fresh water separated from the waters of the Gulf by an irregular and frequently very narrow strip of land of river deposit. The greatest elevation of the surface above sea level is on the bank of and near to the stream. On the other side the land slopes gradually away toward salt water, while toward the fresh water the slope is abrupt.

Two associations are to be recognized, both of which have grasses as the determining elements. These are the *Phragmites, Vigna* and the *Spartina* associations. The former occupies the higher levels and therefore the portion of the bank near the fresh water. The grass makes a dense growth, and spreads by means of the long decumbent stems and stolons. These and the roots bind the soil, which however is gradually eroded, leaving projecting clumps of the grass along the banks. From these clumps the decumbent or prostrate stems project out into the water and sway in the current, extending down stream 30 meters or more. On the highest part of the bank the "canes" form a mechanical support for a very profuse growth of *Vigna glabra* which is almost impenetrable. Occasional trees of *Salix nigra* and vines of *Ampelopsis arborea* are to be seen along the bank.

In the swampy ground of the lower levels which border on the salt water *Spartina* gives the character to the vegetation, and this is often the sole plant. The two associations fade into each other, but there is nevertheless a fairly distinct line of demarkation. As one advances northward and as the land broadens out, a sort of swamp meadow land is found, where occur many grasses and leguminous plants. Here, too, the willows become more numerous and the cypress comes in.

BALLAST

At the lower end of the south pass there occur a number of plants which are adventive from many parts of the world. These have been brought in ballast which has been dumped along the banks near Port Eads where these exotic forms are to be found in considerable profusion. A few have already become established and probably others will be established in the future. The ballast plants are chiefly tropical and subtropical in their origin.

PHYTOGEOGRAPHY

The general geographical relations of the Delta island flora may now be indicated briefly.

We notice with Kearney the infrequency of parasitic fungi, and it seems probable that his explanation is correct, namely that the adaptations which serve to inhibit transpiration enable plants to resist the attacks of parasites. Other fungi are also scarce. A very few boleti and polypori were collected.

The algal flora has already received mention. It may be added that a certain species of green alga occurs in quantity on the surface of the muck marshes, and attached to the lower parts of the stems of *Spartina* and other muck marsh plants. Otherwise the algal flora is very meagre.

Lichens are abundant on the limbs of trees (oaks and myricas) and sometimes on the ground on the larger islands.

Mosses are rare excepting in a few favored localities on the larger islands.

Liverworts are rather more abundant but are not striking in quantity or number of species. Some *Lejeunea* forms occur indicating a general tropical character of the hepatic flora.

Certain widely distributed ferns occur, and these will be mentioned in the list. They do not, however, form more than a weak element in the plant covering of the larger islands.

Regarding the spermatophyta we may make the following provisional statements :

1. Extended sand plains, removed from the direct influence of

salt water, make possible the growth of a large number of plants characteristic of the austro-riparian. These plains present the appearance of the typical pine barrens, with the absence of magnolias and deciduous oaks. The trees are *Pinus Taeda*, *P. palustris*, *Quercus geminata* and, less frequently, *Q. Virginiana*. As woody undergrowth *Sabal glabra*, *Serenoa serrulata* and a large congeries of herbaceous plants common to the austroriparian. In this regard the larger of the Delta islands stand in contrast with Ocracoke. A few of the genera may be mentioned as indicating the type of vegetation : *Aristida*, *Ascyrum*, *Andropogon*, *Drosera*, *Helianthemum*, *Gerardia*, *Hypericum*, *Lacinaria*, *Lechea*, *Opuntia*, *Panicum*, *Polygala*, *Rhexia*, *Sabbatia*, *Willughbaea*.

2. Certain plants are distributed far to the north and are found as strand plants.

**Baptisia leucantha*.
Cenchrus tribuloides.
**Eclipta alba*.
Euphorbia polygonifolia.
Monarda punctata.
Rhus copallina.
Ruppia maritima (in saline waters).
**Smilax Bona-nox*.
Strophostyles helvola.
Triglochin striata (Maryland).
Triplasis (*Sieglingia*) *purpurea*.
Vitis aestivalis.

Moseley has shown that the appearance of a certain number of plants of southern distribution in the region of Sandusky Bay, Lake Erie, is due to the higher temperature and longer growing season. A mean difference of nearly 5° F. as compared with the climate of Buffalo is noticed. Those plants marked thus * in the above list occur also at Sandusky Bay.

The following are found in North America only on the Atlantic coast as far north as indicated.

Baccharis halimifolia (Mass.).
Borrichia frutescens (Va.).
Croton maritimus (N. C.).
Distichlis spicata (Nova Scotia).
Gerardia maritima (Me.).
Ilex vomitoria (N. C.; Va.?).
Iva frutescens (Mass.).
Juncus scirpoides (N. Y.).
Kosteletskya Virginica (N. Y.).
Xanthoxylum Clava-Herculis (N. C.; Va.?).

Lippia nodiflora (Ocracoke Island, N. C.).
Opuntia Pes-corvi (N. C.).
Panicum amarum (changing to var. *minus* in its northern range).
Pluchea camphorata (Mass.; West Indies).
Salicornia ambigua (Mass.).
Salicornia Bigelovii (Nova Scotia).
Seutera (*Vincetoxicum*) *palustre*.
? Solidago sempervirens (New Brunswick).
Spatina patens (Newfoundland).
Spartina polystachya (Me.).
Yucca gloriosa (Ocracoke Island, N. C.).

4. Strand plants of tropical or subtropical distribution.

(*a*) Tropical plants of the New World:

Batis maritima.
Canavalia obtusaefolia.
Centella Asiatica.
Chrysoma pauciflosculosa.
Iva imbricata.
Lippia nodiflora.
Sabal glabra.
Serenoa serrulata.
Uniola paniculata (Virginia, West India, and South America).

(*b*) Tropical plants, circumterrestrial, or occurring at least in the Old and New World:

Avicennia nitida.
Ipomoea acetosaefolia.
Ipomoea Pes-caprae.
Lithophila (*Philoxerus*) *vermicularis.*
Sesuvium portulacastrum.

5. A few plants of very wide distribution occur as weeds, especially in the shell dune formation. The following are the principal ones:

Ambrosia artimisaefolia.
Lepidium Virginicum.
Leptilon Canadensis.

List of Species[*]

In the preparation of this list we have followed, as closely as possible, the nomenclature given in Britton and Brown's Flora of North America, the family sequence being that of Engler and Prantl, while the genera and species are arranged alphabetically. In addition to the species actually collected on this trip we have added several which have been collected previously by one of the authors (S. M. T.) on the same islands. The algae, some fungi and bryophytes collected have not yet been studied and therefore do not appear. We are indebted to Dr. N. L. Britton, Dr. J. K. Small, Mr. G. V. Nash, Dr. E. L. Greene, Dr. C. F. Millspaugh, Prof. F. Lamson-Scribner and Prof. F. S. Earle for the identification of numerous specimens.

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[*] Plants reported by Kearney (6) as occurring on Ocracoke Island marked *. Those occurring in the strand flora of New Jersey, reported by Harshberger (4) thus †.

Cercospora sp. On *Ipomoea acetosaefolia*, Breton Island.

Puccinia paspali T. & E. On *Paspalum Vaseyanum*, Port Eads.

Uromyces euphorbiae C. & P. On *Euphorbia prostrata*, Cat Island.

U. polygoni (Pers.) Fckl. On *Polygonum littorale*, Ile à Pitre.

OSMUNDACEAE

† *Osmunda regalis* L. Occasional on Cat and Breton Islands.

POLYPODIACEAE

Pteris aquilina caudata (L.) Hook. Cat and Breton Islands.

SALVINIACEAE

Azolla Caroliniana Willd. In quiet coves, mud lumps, near Passa Loutre, washed down by the currents. The plant was also collected floating in the stream, with *Lemna* sp.

PINACEAE

* †*Juniperus Virginiana* L. Two old trees on Cat Island, not observed elsewhere.

Pinus palustris Mill, *P. serotina* Michx., *P. Taeda* L. These three pines are abundant on Ship, Cat and other sandy islands, but are never found in black muck or very wet soils.

Taxodium distichum (L.) L. C. Rich. Occasional on Cat Island; the Delta.

TYPHACAE

* † *Typha latifolia* L.

Common in marshy places, even where the water is quite brackish, and one of the characteristic growths along the river banks. Almost the first species to take possession of the newly formed land about the jetties.

NAIADACEAE

† *Ruppia maritima* L. Common in brackish ponds.

SCHEUCHZERIACEAE

* *Triglochin striata* R. & P. Common in mouths of bayous on the larger islands.

ALISMACEAE

Sagittaria graminea cycloptera J. G. Smith. Ship Island, on margin of pond.

S. lancifolia L. On marshy ground, South Pass.

GRAMINEAE

Andropogon Elliottii Chapm. Occasional on dry knolls on the larger islands.

A. glomeratus Walt. Rather common on margins of ponds on sandy islands.

A. maritimus Chapm. Common on drifting sands only. Florida to Mississippi on the coast.

†*A. Virginicus* L. Occasional on Cat and Breton Islands.

Aristida dichotoma Michx. Ship and Cat Islands.

A. gracilis Ell. In one locality on Cat Island.

A. lanata Poir. Occasional in dry woods, Cat Island.

†*A. purpurascens* Poir. On dry sandy soil, somewhat remote from the beach on Cat Island.

A. spiciformis Ell. On sandy marsh, Ship Island.

**Capriola Dactylon* (L.) Kuntze. Abundant everywhere except on the muck marshes and high dunes, very abundant on the mud lumps. Introduced.

Cenchrus incertus M. A. Curtis. Abundant on sandy soils, and the most common species of the genus. A pine barren grass. Southern Jersey southward.

C. megacephalus Doell. Abundant just above the tide line on all sandy beaches, but not found elsewhere.

†*C. tribuloides* L. Common on sandy islands.

**Chloris petraea* Sw. Common in the interior of all sandy islands.

†*Diplachne fascicularis* (Lam.) Beauv. On low, wet sandy barrens, Ship and Cat Islands.

* †*Distichlis spicata* (L.) Greene. Abundant on damp soils, especially on the muck marsh islands.

Elymus Virginicus L. (?) Occasional on shell beaches, Ile à Pitre and Sam Holmes Islands.

Eragrostis hirsuta (Michx.) Nash. In a single locality, Breton Islands. Perennial.

**E. Elliottii* S. Wats. Occasional on dry sand.

E. pectinacea (Michx.) Steud. Common except on muck soils.

E. secundiflora Presl. Rather common on the drier soils of Ship, Cat and Breton Islands, many of the panicles of the plants on Breton Island being strongly viviparous, a peculiarity not found elsewhere. Confined to the gulf coast.

Erianthus saccharoides Michx. Cat and Breton Islands.

Chaetochloa corrugata parviflora (Poir.) Scribn. & Mer. Port Eads.

C. glauca (L.) Scribn. Port Eads.

C. gracilis (H.B.K.) Scribn. & Mer. Common on ballast ground, Port Eads.

* †*C. imberbis* (Poir.) Scribn. Ile à Pitre and Cat Island, on sandy beaches.

C. magna (Griseb.) Scribn. Abundant on low wet black soil on Breton Island, occasional on Bird and Battledore Islands.

* †*Panicum amarum* Ell. Very abundant on Battledore, Breton and other southern islands, but rare near the Mississippi and Louisiana coasts.

P. angustifolium Ell. Occasional on Cat and Breton Islands.

P. colonum L. Ship and Cat Islands.

†*P. Crus-galli* L. Occasional on margins of ponds on the larger islands and very abundant in the marshes along the river.

P. depauperatum Muhl. Occasional on Breton Island.

P. gibbum Ell. In one locality on Cat Island. Coastal plain from southeast Virginia to Florida, and westward to Texas and Cuba.

Panicum halophilum Nash

P. repens L. var. *confertum* Vasey, not *P. confertum* Desv. 1816.

A smooth and glabrous perennial with a long, stout rootstock from which arise rather stout erect stems which are densely clothed toward the base with overlapping leaves. Stems 1.5–4 dm. tall; leaves crowded below, scattered or wanting above; sheaths with the margin often ciliate; ligule a narrow scarious ring less than 0.5 mm. wide; blades firm, flat, lanceolate, usually 2–6 cm. long, sometimes longer, 3–8 mm. wide; panicle dense, 2–9 cm. long, its branches ascending; spikelets crowded, glabrous, about 2.5 mm. long and a little over 1 mm. wide, the first scale one half as long as the spikelet, or nearly so, the apex acute at a broad angle, apiculate.

In sand along the seashore acting as a sand-binder, Mississippi. Also in Mexico. Collected on Petit Bois Island, Mississippi, by S. M. Tracy, on May 8, 1898, no. 4566, and distributed as *P. repens confertum*. While resembling *P. repens* in general habit, its smaller dense panicle and the larger acute first scale of the spikelet will at once distinguish it. In *P. repens* the panicle is long and slender, and the first scale of the spikelet is only about a fourth as long as the spikelet and truncate at the apex.

Very common on beaches and damp, sandy places on all the islands, the horizontal creeping rootstocks often three metres in length and rarely producing tubers.

P. hians Ell. Common in wet, sandy places.

P. Nashianum Scribn. Dry, sandy banks, Cat Island. Common on dry sandy places, usually in the shade of palmettoes or other shrubs. Pine barrens.

†*P. proliferum* Lam. Observed only near an old house at South Pass. A straw grass.

P. repens L. Occasional on the dunes and dry sand ridges of Ship and Cat Islands, the abundant tubers on the perpendicular rootstocks often buried to a depth of eight decimetres.

P. sphaerocarpon Ell. Cat and Breton Islands.

P. Walteri Pursh. In wet, sandy places, Breton Island.

**Paspalum ciliatifolium* Michx. Common on the larger islands.

P. compressum Nees. Occasional on the larger islands, abundant on the mud lumps, and at Port Eads.

P. Curtissianum Steud. Cat Island.

**P. distichum* L. On wet, black, heavy soil on several islands; very abundant at South Pass and along the jetties.

P. Floridanum Michx. Cat Island.

P. membranaceum Walt. On margins of ponds, Ship and Cat Islands.

P. paspaloides (Michx.) Scribn. One locality on Ship Island.

P. plicatulum Michx. Abundant on rich, damp soil, Ship, Cat and Breton Islands.

P. setaceum Michx. Common on the larger islands.

P. Vaseyanum Scribn. Port Eads. Has been found by one of the writers (S. M. T.) at New Orleans and Mobile, but not elsewhere along the coast.

Phragmites Phragmites (L.) Karst. Occasional on wet soil on nearly all of the islands, and the most common species on the low mud flats, from Cubit's Gap to the mouth of the river, often growing in the edge of the water and producing floating, proliferous canes from five to eight metres in length. The predominant species on the low, newly-formed land near the jetties.

Spartina junciformis Engelm. & Gray. Entirely confined to the Gulf coast.

* † *S. patens* (Ait.) Muhl., † *S. polystachya* (Michx.) Ell., * † ? *S. stricta* (Ait.) Roth. All of these species were found very abundantly on nearly or quite every island and locality visited, *S. patens* and *stricta* being the more common species in the interior of the islands, while the others are confined principally to within a few meters of the beach.

* *Sporobolus Indicus* (L.) R. Br. Rare on the larger islands; abundant on made ground, from South Pass to Port Eads.

S. junceus (Michx.) Kunth. Not rare on dry knolls, Cat and Breton Islands.

S. Virginicus (L.) Kunth. On sandy beaches just above tide, often forming a dense sod-like growth.

Stenotaphrum secundatum (Walt.) Kuntze. Occasional on Breton Island and at South Pass.

S. filiforme (L.) Nash. Abundant on Cat Island, spikes often 3 dm. in length.

Syntherisma fimbriatum (Link) Nash. On dry beaches, Cat Island.

S. humifusum (Pers.) Rydb. Somewhat common on dry soil, Cat and Breton Islands.

S. sanguinale (L.) Nash. Common everywhere except on muck marshes.

Triplasis Americana Beauv. Occasional on dry, sandy soil in pine woods, Cat Island.

T. purpurea (Walt.) Chapm. On dry, sandy knolls, Cat, Hog, Battledore and Ship Islands.

Uniola longifolia Scribn. Occasional in moist woods, Cat Island.

**U. paniculata* L. Very abundant on Ship, Cat and Breton Islands, the larger lumps sometimes producing as many as sixty culms, and forming a striking feature of the dry and almost naked sand hills.

CYPERACEAE

**Cladium effusum* Torr. On borders of ponds, Ship, Cat and Breton Islands; common at South Pass and Port Eads.

Cyperus articulatus L. One locality on a dry, sandy beach, Cat Island.

*?†*C. cylindricus* (Ell.) Britton. Larger heads and broader leaves than those of the eastern type. Common on Ship and Cat Islands; occasional on Breton Island and at Port Eads.

C. erythrorhizos Muhl. Breton Island.

C. ferox Vahl. Cat and Breton Islands, not common.

C. flavus (L.) Boeckl. On ballast ground, Port Eads.

C. Haspan L. On wet, sandy soil, Ship and Cat Islands.

C. inflexus Muhl. South Pass.

C. Lecontei Torr. Common on damp, sandy soil on the larger islands; the rootstocks often two or three metres in length.

C. lutescens Torr. & Hook. Port Eads; Battledore Island.

C. microdontus Torr. Sand, Breton Island. Not common.

C. polystachyus Rottb. Widely distributed in tropical regions. On ballast ground, Port Eads. The Torrey Herbarium contains a specimen of this collected in New Orleans many years ago, probably about 1820, and one from St. Augustine, Fla., 1876, A. P. Garber.

C. prolixus H.B.K. In flower only; unknown hitherto in North America; ballast, Port Eads.

C. Surinamensis Rottb. On ballast ground, Port Eads. Doubtless adventive from the Caribbean region.

C. vegetus Willd. In wet meadow, South Pass.

C. virens Michx. In one locality at South Pass and on Breton Island.

**Dichromena colorata* (L.) A. S. Hitchcock. Rather common on the wet, sandy soils of the larger islands; not observed on the mainland, where it is replaced by *D. latifolia* Baldw.

* ?*Eleocharis albida* Torr. In a wet meadow, South Pass.

Fimbristylis autumnalis (L.) R. & S. Common.

†*F. castanea* (Michx.) Vahl. Common.

F. laxa Vahl. Ship Island and Port Eads.

**F. spadicea* (L.) Vahl. Breton and Cat Islands.

F. Vahlii (Lam.) Link. Common at South Pass.

Hemicarpa micrantha (Wahl.) Britton. Wet sand on Ship Island and river bank at South Pass.

Kyllingia brevifolia Rottb. In a wet meadow, South Pass.

Rynchospora dodecandra Baldw. On a sandy knoll in shade of oak trees, Cat Island.

R. fascicularis (Michx.) Vahl. Occasional on Cat Island.

* †*Scirpus Americanus* Pers. Breton Island and South Pass.

†*S. robustus* Pursh. On mud lumps.

Scleria triglomerata Michx. Cat Island.

Stenophyllus Stenophyllus (Ell.) Britton. On river bank at South Pass.

SABALACEAE

Sabal glabra (Mill.) Sarg. Occasional on Cat Island.

Serenoa serrulata Benth. & Hook. Abundant on the drier parts of the sandy islands.

LEMNACEAE

Lemna sp. In bays, brackish water, mud lumps.

XYRIDACEAE

Xyris serotina Chapm. On border of marsh, Cat Island.

COMMELINACEAE

Commelina nudiflora L. Cat and Breton Islands.

C. Virginica L. Breton Island.

PONTEDERIACEAE

Pontederia cordata L. Abundant along the river from Cubit's Gap to Port Eads.

JUNCACEAE

†*Juncus marginatus biflorus* Wood. Common on Ship and Cat Islands.

* †*J. scirpoides* Lam. Ship, Cat and Breton Islands.

LILIACEAE

**Yucca gloriosa* L. Abundant on sand hills, Breton Island.

SMILACEAE

Smilax auriculata Walt. Breton Island.

**S. Bona-nox* L. Common on dry, sandy beaches above tide line.

MYRICACEAE

* †*Myrica cerifera* L. Common on all islands producing shrubs, often forming dense thickets on the borders of marshes, Ile à Pitre, Cat and Breton Islands.

SALICACEA

Populus deltoides Marsh. Occasional on newly-made ground from South Pass to the jetties.

Salix nigra Marsh. Very abundant from South Pass to the jetties. The wood of this species is used almost exclusively in making the mattresses to form the jetties and the young trees are among the first to take possession of the newly-formed banks.

FAGACEAE

Quercus geminata Small. The common oak of Ship and Cat Islands.

**Q. Virginiana* Mill. Occasional on the islands, and the common form on the mainland.

MORACEAE

Toxylon pomiferum Raf. A single tree on ballast ground, Port Eads.

POLYGONACEAE

Polygonella gracilis Meisn. Occasional on sandy knolls, Ship and Cat Islands.

Polygonum littorale Link. On shell beaches, Ile à Pitre and Battledore Island.

P. Opelousanum Ridd. Ship and Cat Islands.

P. punctatum robustior Small. In wet meadows, South Pass.

* *? Rumex verticillatus* L. On mud lumps.

CHENOPODIACEAE

Atriplex cristata H.B.K. On mud lumps and Breton Island.

**Chenopodium anthelminticum* L. On ballast grounds, Port Eads.

C. Berlandieri Moq. Common on sandy beaches.

†*Dondia linearis* (Ell.) Heller. Common on low, barren sand spits, Breton, Bird and Battledore Islands.

†*Salicornia ambigua* Michx.

†*S. Bigelovii* Torr.

Common on all saline marshes, and often forming the bulk of the vegetation over extensive areas. Both of the species are also found occasionally on wet and rather barren sand just above tide level.

* †*Salsola Kali* L. Sand beaches and plains, Breton and Bird Islands.

AMARANTHACEAE

Alternanthera philoxeroides Griseb. On ballast ground, Port Eads.

Amaranthus spinosus L. Occasional near an old house, Cat Island.

Froelichia Floridana Moq. On dry, sandy knolls, Ship, Cat and Breton Islands.

Lithophila vermicularis (*lata*) (L.) Uline. A few plants on shell marsh, Bird Island.

Tamariscina concatenata (Moq.) Uline & Bray. Breton Island and mud lumps.

T. tuberculata (Moq.) Uline & Bray. Battledore and Breton Islands.

BATIDACEAE

Batis maritima L. In all muck marshes or in those with a thin covering of sand.

AIZOACEAE

**Mollugo verticillata* L. Abundant on dry sand, Cat Island.

Sesuvium portulacastrum L. Rather common on damp sand or shell beaches.

CARYOPHYLLACEAE

Scleranthus annuus L. Occasional on sandy islands.

Siphonychia corymbosa Small. Occasional on Ship Island, which is the type locality, and abundant on Cat Island.

Stipulacida setacea Michx. Cat and Breton Islands.

NYMPHAEACEAE

Castalia tuberosa (Paine) Greene. In pond on Cat Island.

MENISPERMACEAE

Cebatha Carolina (L.) Britton. Occasional on Cat and Breton Islands.

LAURACEAE

Persea pubescens (Pursh) Sarg. Cat Island.

PAPAVERACEAE

Argemone Mexicana L. A few plants on ballast ground, Port Eads.

CRUCIFERAE

Cakile fusiformis Greene. On sand and shell beaches, Bird, Battledore and Breton Islands.

Lepidium Virginicum L. Battledore and Sam Holmes Islands.

DROSERACEAE

Drosera rotundifolia L. Wet sand, Cat Island.

ROSACEAE

**Rubus trivialis* Michx. Cat and Breton Islands.

Rubus sp. An unidentified species belonging to the *trivialis* group is very abundant on one of the larger mud lumps, where it makes a growth so rank and dense as to be almost impenetrable.

MIMOSACEAE

Acuan brachyloba (Benth.) Kuntze. In field at South Pass.

A. Illinoensis (Michx.) Kuntze. On shell beach, Ile à Pitre.

Mimosa strigillosa T. & G. Common at South Pass.

CAESALPINACEAE

Chamaecrista sp. Very abundant on low, damp, sandy soil on Breton Island.

Chamaecrista robusta Pollard. A few plants on dry situations on Cat Island.

PAPILIONACEAE

**Aeschynomene Virginica* (L.) B.S.P. Occasional on Cat Island, abundant at South Pass.

A. viscidula Michx. Ship and Cat Islands, on dry beaches.

Amorpha fruticosa L. South Pass and Port Eads.

Baptisia leucantha T. & G. A few plants on Cat Island.

Bradburya Virginiana (L.) Kuntze. Common on Breton and Cat Islands. A form with almost linear leaflets (var. *angustifolia*) at South Pass.

Canavalia obtusifolia DC. A few plants on Breton Island.

Clitoria Mariana L. Cat and Breton Islands.

Crotalaria ovalis Pursh. Cat Island.

C. rotundifolia (Walt.) Poir. Port Eads.

**Galactia volubilis* (L.) Britton. Abundant except on black, marshy soil.

Indigofera Caroliniana Walt. Occasional on Cat Island and at Port Eads.

Melilotus Indica (L.) All. On ballast ground, Port Eads.

Rhynchosia menispermoides DC. Dry, sandy woods, Cat Island.

Sesban macrocarpa Muhl. Occasional on Cat Island, abundant at Port Eads.

†*Strophostyles helvola* (L.) Britton. Very abundant on all dry, sandy soil excepting on the high dunes.

Stylosanthes biflora (L.) B.S.P. Common on Cat Island.

Trifolium repens L. Occasional along river bank at South Pass.

Vigna glabra Savi. Abundant in nearly every locality visited excepting the low salt marshes and high sand hills, often forming a dense growth covering several acres.

OXALIDACEAE

Oxalis corniculata L. Cat Island.

O. stricta L. Common.

LINACEAE

Linum Floridanum (Planch.) Trelease. Abundant on Breton Island.

RUTACEAE

**Xanthoxylum Clava-Herculis* L. Occasional on Cat Island.

MELIACEAE

Melia Azederach L. The only large trees on the mud lumps.

POLYGALACEAE

Polygala grandiflora L.

P. nana DC. Cat Island; rare.

EUPHORBIACEAE

**Acalpha gracilens* A. Gray. Common on Ship, Cat and Breton Islands.

Croton capitatus Michx. Abundant at Port Eads.

**C. maritimus* Walt. Occasional on Ship and Cat Islands.

C. sp. Cat Island. (L. & T., 205.)

Euphorbia Brasiliensis Lam. On ballast ground, Port Eads.

E. cordifolia Ell. Cat Island.

E. maculata L. Ile à Pitre and Port Eads.

* †*E. polygonifolia* Ell. Cat and Battledore Islands.

E. prostrata Ait. Ship Island.

E. serpens radicans Engelm. Port Eads.

Jatropha stimulosa Michx. Common on Cat Island, in sand, in the shade of trees, especially live-oaks, occasional on Breton.

ANACARDIACEAE

†*Rhus copallina* L. Occasional on Cat Island.

ILICACEAE

**Ilex vomitoria* Ait. Abundant on Ship, Cat and Breton Islands, occasional on Ile à Pitre and Battledore Island.

VITACEAE

Ampelopsis arborea (L.) Rusby. Cat Island and South Pass.

* † *Vitis aestivalis* Michx. Occasional on Cat Island.

MALVACEAE

Hibiscus lasiocarpus Cav. In wet meadows at South Pass.

* †*Kosteletzkya Virginica althaefolia* Shuttlw. Occasional on Breton Island.

Sida rhombifolia L. Common at Port Eads.

S. spinosa L. Cat and Breton Islands.

HYPERICACEAE

Ascyrum cuneifolium Chapm. Cat Island.

Hypericum Drummondii (Grev. & Hook.) T. & G. Cat Island.

Sarothra gentianoides L. Cat and Breton Islands.

CISTACEAE

Helianthemum corymbosum Michx. Abundant on Cat Island.

H. Georgianum Chapm. On a dry, sandy knoll, Cat Island.

Lechea minor L. Ship, Cat and Breton Islands.

**L. villosa* Ell. Common on Cat Island.

TURNERACEAE

Turnera ulmifolia L. On ballast ground, Port Eads.

CACTACEAE

Opuntia Opuntia (L.) Walt. Common on Cat and Breton Islands, and Isle à Pitre.

**O. Pes-corvi* LeConte. Occasional on dry, sandy soil, Cat Island.

ONAGRACEAE

Jussiaea Peruviana L.

J. suffruticosa L. On ballast ground, Port Eads.

**Ludwigia alata* Ell. Margin of pond, Ship Island.

Oenothera laciniata Hill. On ballast ground, Port Eads.

HALORAGIDACEAE

Proserpinaca palustris L. Common on margins of ponds.

UMBELLIFERAE

**Centella Asiatica* (L.) Urban. Abundant on Ship and Cat Islands.

Hydrocotyle Bonariensis Lam. Very abundant and vigorous at Port Eads.

H. sp. Wet sand, Cat Island.

VACCINIACEAE

Vaccinium arboreum Marsh. Occasional on Cat Island.

PRIMULACEAE

†*Anagallis arvensis* L. A single plant, on ballast ground at Port Eads.

* †*Samolus floribundus* H.B.K. Occasional on Cat Island and at South Pass.

PLUMBAGINACEAE

Limonium Nashii Small. Rather common in all saline marshes.

LOGANIACEAE

**Polypremum procumbens* L. Common on the islands in dry soil.

GENTIANACEAE

†*Sabbatia stellaris* Pursh. Abundant on all islands having a sandy soil.

ASCLEPIADACEAE

Asclepias amplexicaulis Michx. Abundant on dry, sandy knolls, Ship, Cat and Breton Islands.

**Seutera palustris* L. Abundant on saline marshes and on sandy beaches.

CONVOLVULACEAE

Breweria sp. Dry knolls, Cat Island.

†*Convolvulus sepium* L. On upper sand beach, Battledore Island.

†*Ipomoea acetosaefolia* R. & S. Common on Breton Island.

I. Carolina (L.) Pursh. Cat and Breton Islands.

I. Pes-caprae (L.) Sweet. Very abundant on dry sand.

**I. sagittata* Cav. Common on damp, sandy beaches.

CUSCUTACEAE

Cuscuta arvensis Beyr. Bird and Cat Islands.

C. Gronovii Willd. Quite common, and usually on *Iva frutescens.*

BORAGINACEAE

Heliotropium Curassavicum L. Occasional in nearly all localities.

H. Indicum L. Breton Island, the mud lumps and Port Eads.

H. inundatum Sw. On ballast ground, Port Eads.

VERBENACEAE

Avicennia nitida Jacq. Rather common from Mitchell Key southward.

Lantana Camara L. Abundant on ballast ground, Port Eads.

**Lippia nodiflora* (L.) Michx. Very common on damp soil.

Verbena littoralis H.B.K. On ballast ground, Port Eads.

V. officinalis L. Port Eads.

V. urticaefolia L. Occasional at South Pass.

LABIATAE

Clinopodium coccineum (Benth.) Kuntze. On dry, sandy knolls, Cat Island.

Lycopus Europaeus L. One locality on beach, Cat Island.

†*Mentha rotundifolia* (L.) Huds. Port Eads.

* †*Monarda punctata* L. A single clump on beach, Cat Island.

* ? *Teucrium* sp. Apparently an undescribed species, related to *T. Nashii.* Occasional on Cat Island.

SOLANACEAE

Lycium Carolinianum Walt. Common on shell beaches, Battledore, Sam Holmes and Sundown Islands.

Physalis angustifolia Walt. Abundant on dry sand, Cat and Breton Islands.

P. mollis cinerascens (Dunal.) A. Gray. On ballast ground, Port Eads.

**P. viscosa* L. On ballast ground, Port Eads. These specimens correspond closely with the true *P. viscosa* from South America, the common North American plant passing under that name probably being a distinct species.

Solanum gracile Link. Occasional on Breton Island.

S. nigrum L. Battledore Island and Port Eads.

S. rostratum Dunal. On ballast ground, Port Eads.

SCROPHULARIACEAE

**Gerardia maritima* Raf. Abundant on Cat and Breton Islands.

Gratiola hispida (Benth.) Pollard. Wet sand, Cat Island.

**Monniera Monniera* (L.) Britton. Cat Island and South Pass.

LENTIBULARIACEAE

Utricularia subulata L. Cat Island.

RUBIACEAE

**Diodia teres* Walt. Common.

* †*D. Virginiana* L. Common.

* ?*Galium hispidulum* Michx. Occasional among bushes on Cat Island.

Houstonia rotundifolia Michx. In rich, damp woods, Cat Island.

Mitchella repens L. Occasional on Cat Island.

**Oldenlandia uniflora* L. Cat Island.

CUCURBITACEAE

**Citrullus vulgaris* Schrad. One plant, Bird Island.

CAPRIFOLIACEAE

Sambucus Canadensis L. South Pass and Port Eads.

COMPOSITAE

Acanthospermum australe (L.) Kuntze. Port Eads.

Actinospermum uniflorum (Nutt.) Barnhart. Occasional on Ile à Pitre.

Aster exilis Ell. Bird Island and Port Eads.

†*Baccharis halimifolia* L. Mud lumps.

Bidens leucantha Willd. Abundant at South Pass and Port Eads.

Baldwinia multiflora Nutt. Dry sand hummocks, Cat Island.

Boltonia diffusa Ell. Cat Island.

**Borrichia frutescens* (L.) DC. Abundant on Breton Island and Ile à Pitre.

Chrysoma paucifloscuIosa (Michx.) Greene. On dry sand hills, Cat and Ship Islands.

†*Chrysopsis Mariana* (L.) Nutt. Occasional on Cat Island.

Eclipta alba (L.) Hassk. Common on wet, sandy soil on the larger islands.

* †*Erechtites hieracifolia* (L.) Raf. A single locality on Hog Island.

Erigeron repens A. Gray. Damp, sandy soil, Breton Island; not before reported from east of Texas.

**Gnaphalium purpureum* L. Common on Cat and Breton Islands; a single plant observed at Port Eads.

Helenium tenuifolium Nutt. Abundant at Port Eads, but not observed elsewhere.

Heterotheca subaxillaris (Lam.) Britton & Rusby. Occasional on Cat Island.

* †*Iva frutescens* L. The most common shrub on all low, sandy islands.

I. imbricata Walt. Common on Breton Island; occasional on Sam Holmes, Hog and other sandy islands to the southward.

* †*Leptilon Canadense* (L.) Britton. Common on sand or shell beaches.

L. linifolium (Willd.). Occasional on Cat Island.

* †*Pluchea camphorata* (L.) DC. A few plants on Bird Island and at South Pass.

**P. foetida* (L.) B.S.P. Common on Cat Island.

* †*Solidago sempervirens* L. Not collected in flower, but presumed to be this plant. Breton Island.

Sonchus oleraceus L. Common on shell beaches, Sam Holmes, Sundown and other islands.

Trilisa odoratissima (Walt.) Cass. Abundant on Cat Island.

* †*Willughbaea scandens* (L.) Kuntze. Common on mud lumps, occasional on Cat and Breton Islands.

* ?*Xanthium strumarium* L. A single plant, on Breton Island.

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A very full list of references to the literature dealing with ecology will be found in Kearney's paper cited below.

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Explanations of Plates

PLATE 8. *Panicum amarum* dunes, with *Ipomoea acetosaefolia* on the extreme left foreground and *I. pes-caprae* on the extreme right.

PLATE 9. *Iva imbricata* dunes on the sand spit plain; a stem of *Ipomoea Pes-caprae* in the foreground.

PLATE 10. Sand spit plain. *Serenoa serrulata* dunes. In the middle foreground a *Panicum repens* dune. Left foreground *Cyperus cylindricus*. *Pinus Taeda* in the background; pine graveyard on the right.

PLATE 11. Shell dune showing lee margin encroaching on a pure *Batis* association. On the dune *Iva frutescens*.